LIICG - A NEW METHOD FOR ROTATIONAL AND RO-VIBRATIONAL SPECTROSCOPY AT 4K

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Since many years low temperature ion trapping techniques are successfully used in our laboratories in combination with sensitive action spectroscopy schemes (Laser Induced Reactions) to measure high resolution ro-vibrational and rotational spectra of gas-phase molecular ions. Here we present a further development of a LIR method first introduced for recording rotationally resolved electronic spectra of N_2^+ [b]. This new method, called LIICG (Light Induced Inhibition of Complex Growth), makes use of state specific He-attachment rates to stored cold molecular ions. We have recently demonstrated its applicability to rotational and ro-vibrational spectroscopy of C_3H^+ and CH_5^+ [c]. The measurements were performed in recently completed 4K 22-pole ion trap instruments. Ionic species are produced in a storage ion source and are mass selected before they enter the trap. For spectroscopy normally a few thousand ions are stored at 4K together with He at high number densities (around 10^{14} cm^{-3}). Under these conditions He attaches to the ions via ternary collision processes. As we will show, this attachement process is hindered by exciting a rotational or ro-vibrational transition, likely because the attachment rates for He are slower for higher rotational or ro-vibrational levels. So by exciting the bare ion the number of ion- He complexes at equilibrium is reduced. In this way the spectrum of the bare ion can be recorded by counting the number of ion-He complexes as a function of frequency. To test the new method we chose well known rotational ground state transitions of CO^+, HCO^+ and CD^+. In particular CD^+ appeared to be a good candidate for understanding the new method in detail, due to its strong LIICG signal and its simple rotational spectrum. In this contribution we will explain the LIICG scheme and its underlying kinetics using the example of CD^+. We will show effects of different experimental conditions on the signal (e.g. He number density, temperature, radiation power...) to explain our kinetic model. Beside these tests we will present measurements of new rotational transitions of C_3H^+, CD_2H^+ and CH_2D^+, demonstrating LIICG as a general spectroscopic method.

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[a] also: Radboud University Nijmegen, Institute for Molecules and Materials (IMM), Nijmegen, Netherlands

[b] Chakrabarty et al. 2013, J. Phys. Chem. Lett., 4, 4051

[c] S. Brünken et al. 2014, ApJL, 783, L4; O. Asvany et al. 2014, ApPhB, 114, 203-211